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(71) Applicant *(for all designated States except US)*: INSTITUUT VOOR MILIEU- EN AGRITECHNIEK (IMAG-DLO) [NL/NL]; P.O. Box 43, NL-6700 AA Wageningen (NL).

(72) Inventor; and

(75) Inventor/Applicant *(for US only)*: ERADUS, Willem, Johannes [NL/NL]; Anker 34, NL-3904 PM Veenendaal (NL).

(74) Agent: DE BRUIJN, Leendert, C.; Nederlandsch Octrooibureau, Scheveningseweg 82, P.O. Box 29720, NL-2502 LS The Hague (NL).

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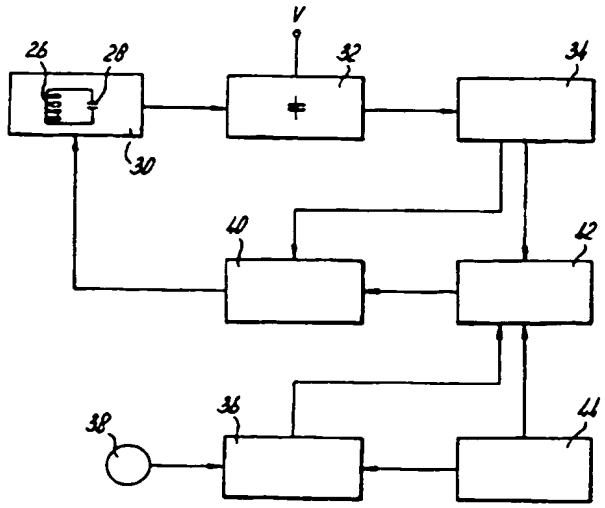

(57) Abstract

Transponder provided with: a receiving circuit for receiving interrogation signals and electromagnetic field energy, energy storage means for storing the received electromagnetic field energy and for delivering power to the transponder, interrogation signal processing means for detecting the interrogation signal, a measuring circuit coupled to one or more sensors for measuring the value of one or more external ambient parameters, and a transmitting circuit which, after reception of an interrogation signal, transmits the parameter value(s) measured by the measuring circuit. The transponder is furthermore provided with a time-determining circuit which activates the measuring circuit at predetermined times to carry out one or more measurements of the said ambient parameter(s). The measuring circuit is provided with a memory in which a number of measured parameter values can be stored. The energy storage means have sufficient capacity to supply power within a predetermined period to the time-determining circuit in order to keep it in operation during said period and also to supply power to the measuring circuit if it is activated within said period by the time-determining circuit.

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Transponder containing measuring circuit

The invention relates to a transponder provided with:

- a receiving circuit for receiving interrogation signals and electromagnetic field energy,
- energy storage means for storing the received electromagnetic field energy and for delivering power to the transponder,
- interrogation signal processing means for detecting the interrogation signal,
- a measuring circuit coupled to one or more sensors for measuring the value of one or more ambient parameters,
- a transmitting circuit which, after reception of an interrogation signal, transmits the parameter value(s) measured by the measuring circuit.

Such a transponder is described, for example, in US Patent Publication US-5,073,781. This transponder functions in such a way that, whenever an interrogation signal is received, electromagnetic energy is drawn from the interrogation field and is stored in the energy storage means, which are constructed as a capacitor. As soon as the capacitor is completely charged, the interrogation signal processing means are activated and after recognition of the interrogation signal they activate the measuring circuit with which an external ambient parameter value, for example the current temperature, is measured by means of the sensor coupled to it. The transmitting circuit, which first of all transmits an identification signal and then the measured parameter value is then also activated.

Provided said transponder is situated in the interrogation field and therefore receives interrogation signals and high-frequency electromagnetic field energy, the measuring circuit can also be activated to measure and transmit the current ambient parameter value. If the transponder leaves the interrogation field, the energy from the capacitor will be used up after a relatively short time and the transponder therefore becomes completely passive. With this transponder, it is therefore possible to carry out measurements only at times at which the transponder is situated in the interrogation field and an interrogation signal is therefore received.

Circuits which operate in a similar manner and also become active only if they come within the sphere of influence of an interrogating station are described in Patent Publications US-4,075,632, US-5,053,774, US-5,252,962, EP-0,395,188, EP-0,554,955, DE-3,219,558, DE-3,932,428, DE-3,922,556 and GB-2,258,588.

From the various publications mentioned above it is evident that sensors of various types can be used, for example for measuring temperature, pressure, light, force, torsion etc. Biosensors can also be used to measure pH, glucose content and the like. Furthermore, it is also possible to use combinations of sensors to determine consecutively or simultaneously the values of a number of parameters.

In many situations it is desirable not only to obtain measured values at those instants at which the transponder is situated within an interrogation field, but also to obtain measured values which relate to other times.

A device known per se with which measured values can be generated which are independent of the occurrence of an interrogation signal is described in US Patent Publication US-4,865,044. Said device contains a clock generator, a time-determining circuit, a code generator, a temperature measuring circuit and a transmitter. Said known device is furthermore provided with a battery with which the various circuits in the device are supplied. In order to make the service life of the battery as long as possible, said known device is furthermore provided with a time-determining circuit with which the code generator, the temperature measuring device and the transmitter are activated only briefly at predetermined times in order to measure and transmit the temperature at the respective times. In the intervening periods, only the clock-pulse generator is active for switching a clock mechanism or counter mechanism until the subsequent predetermined time is reached.

One of the disadvantages of said known transponder is the fact that a battery has to be present and, despite all attempts to allow the device as a whole to function at as low a power as possible, said battery nevertheless has a limited service life. In US-4,865,044, a service life is mentioned which varies from six months to 2.1 years, depending on the embodiment. In many cases, however, a much longer service life will be desirable. If, for example, a transponder is used to monitor the body temperature of animals, account will have to be taken of the expected life of the respective animal, which may be much longer. If the service life of the transponder is shorter than the life of the animal, it is consequently necessary either to replace the transponder as a whole or to replace the battery of the transponder.

A further disadvantage of said known device is formed by the fact that the range of the transmitter is relatively limited. In one embodiment, mention is made of a range of 50 feet (approximately 15 metres),

which implies that, depending on the field of application, a large number of receivers sited in a relatively spread-out manner is necessary to be able to receive all the signals transmitted by the respective device. In practice, this can encounter practical drawbacks.

The object of the invention is therefore to provide a transponder of the type mentioned in the introduction, which transponder has an infinite service life (disregarding wear and ageing phenomena) and with which measured values can also be obtained at times which are situated between the times at which the transponder enters an interrogation field.

This object is achieved by a transponder of the type mentioned in the introduction in that

- it is furthermore provided with a time-determining circuit which activates the measuring circuit at predetermined times to carry out one or more measurements of the said ambient parameter(s),
- the measurement circuit is provided with a memory in which a number of measured parameter values can be stored, and
- the energy storage means have sufficient capacity to supply power within a predetermined period to the time-determining circuit in order to keep it in operation during said period and also to supply power to the measuring circuit insofar as it is activated within the said period by the time-determining circuit.

The invention will be explained in greater detail below by reference to the accompanying figures.

Figure 1 shows a block diagram of the transponder known from the prior art.

Figure 2 shows a block diagram of the transponder according to the invention.

Figure 1 shows diagrammatically in the form of a block diagram a transponder such as is known from the above-mentioned prior art. Said transponder comprises in its generality a receiving circuit 10, energy storage means 12, an interrogation signal processing circuit 14, a measuring circuit 16 which is coupled to a sensor 18 for measuring an ambient parameter, and a transmitting circuit 20.

The receiving circuit 10 essentially comprises a tuned circuit composed of the diagrammatically indicated combination of a coil 24 and a capacitor 22, which circuit is tuned to the frequency at which the interrogation signal is generated. If the receiving circuit 10 receives an interrogation signal in the form of modulated high-frequency electromagnetic

field energy, this signal will, on the one hand, be passed to the energy storage means 12 and will also be passed to an interrogation signal processing circuit 14. The high-frequency electromagnetic field energy in the interrogation signal is used in the storage means 12 to charge an energy reservoir which is designed as a capacitor. The energy collected in said energy reservoir is then used, at least temporarily, to supply the signal processing circuit 14, the measuring circuit 16 with associated sensor 18 and the transmitting circuit 20.

As soon as sufficient energy is present in the capacitor 12, the interrogation signal processing circuit 14 will become active and will be able to detect the interrogation signal in the received high-frequency electromagnetic field energy. As soon as the interrogation signal is detected, the signal processing circuit 14 delivers an activation signal to the measuring circuit 16 which, in response to said signal, detects a measured value of the sensor 18. The detected measured value is transmitted from the measuring circuit 16 to the transmitting circuit 20, which has also been activated in the meantime by the signal processing circuit 14. Finally the transmitting circuit 20 ensures that the detected measured value is transmitted in a high-frequency signal train to the external interrogating station. Depending on the circuit, use can be made of the oscillatory circuit which is also present in the receiving circuit 10 to transmit said signal, as is assumed in Figure 1, but, on the other hand, use can also be made of a separate oscillatory circuit, which is not shown in the figure.

With such circuits, a measurement is carried out only after reception of an interrogation signal transmitted by an external interrogation station and the respective measured value is transmitted to the interrogation station immediately thereafter. If the transponder is situated outside the sphere of influence of the interrogation station, the energy storage means (the capacitor 12) are discharged and the transponder is inactive.

For many applications, there is a need for a transponder with which it is possible to carry out measurements between two consecutive interrogation signals.

The invention now meets this need with the transponder, one embodiment of which is illustrated diagrammatically in the form of a block diagram in Figure 2. Said transponder comprises the receiving circuit 30 which contains within it the oscillatory circuit having coil 26 and capacitor 28, the energy storage means 32, the interrogation signal pro-

cessing circuit 34, the measuring circuit 36 with associated sensor 38, and the transmitting circuit 40. Up to this point, there is similarity to the transponder illustrated in Figure 1. However, the transponder from Figure 2 comprises, in addition, a memory 42 and a time-determining circuit 44. Furthermore, the energy storage means 32 are designed in such a way that its capacity is sufficient also to be able to carry out measurements between two interrogation signals and to store the measured values found in the memory, as will be explained in greater detail below.

When an interrogation signal is received, energy is drawn from the high-frequency electromagnetic field in the same way as described above for the transponder of Figure 1 and said energy is used to charge the energy storage means 32. As soon as sufficient energy has been charged into the storage means, the interrogation signal processing circuit 34 is put into operation and the interrogation signal is detected. In response to the latter, the other circuits, such as the transmitting circuit 40 and the memory 42, are activated. The memory 42 contains one or more measured values and these are now supplied sequentially to the transmitting circuit 40 and transmitted to the interrogation station after modulation in a suitable high-frequency signal.

The storage means 32 are provided in this transponder with a chemically inactive capacitor or a chemically active battery or storage battery. In each case, the storage means have sufficient capacity to be able to store a relatively large quantity of energy with which, as will be further described below, the time-determining circuit 44 and, insofar as necessary, also the measuring circuit 36 and possibly the memory 42 can always be supplied until the receipt of a subsequent interrogation signal.

After termination of the interrogation signal and after the transmission of the measured values stored in the memory 42, a large part of the transponder will be inactivated, with the exception of the time-determining circuit 44. Said time-determining circuit 44 contains, inter alia, a clock circuit and a clock-pulse generator, with which pulses are delivered to the clock circuit. In a simple embodiment, a signal with which the measuring circuit 36 with associated sensor 38 and the memory 42 are temporarily activated is generated by the time-determining circuit after termination of a predetermined period. The measuring circuit 36 then generates, on the basis of the signal received by the sensor 38, a measured value and said measured value is stored in the memory 42. Then both the measuring circuit 36 with associated sensor 38 and the memory 42 are again inactivated and

the time-determining circuit 44 begins to measure a subsequent predetermined period. During said period, energy is therefore used up only by the time-determining circuit 44. At the end of the subsequent period, a measurement is again carried out and the measured value obtained is stored in the memory, etc. This takes place just until the transponder enters the interrogation field of an interrogation station. As soon as that happens, the storage means are recharged and the various circuits in the transponder are activated. After recognition of the interrogation signal in the recognition circuit 34, the memory 42 is read out and the measurement data stored in it and collected in the period after the preceding interrogation signal are transmitted to the interrogation station.

In a more advanced embodiment, the time-determining circuit can be designed in such a way that a signal is generated to carry out a measurement and to store the measured value obtained in the memory at predetermined programmed-in times or in a predetermined sequence of different periods.

Depending on the parameter to be measured it may be necessary to keep not only the time-determining circuit 44, but also the measuring circuit 36 or at least a part of it in operation during fairly long periods or even continuously. That is the case, for example, for integrating measurements, such as the measurement of movements. The measuring circuit, or at least that part of it which has to remain switched on, can generally be designed in such a way that its power consumption is very low.

It is furthermore preferable to use for the memory 42 a type in which the information remains present even if the supply voltage fails so that the memory has to be activated only during the storage of new measured values or during the reading-out of measured values.

In the above, it has been assumed that the energy which is stored in the storage means 32 is sufficient to be able to bridge fairly long periods between the interrogation signals without the voltage to the time-determining means falling off. Because the charging of a discharged storage capacitor or a discharged battery or storage battery may take a relatively long time and because it is not always possible to bring the transponder within the interrogation field during this required time, it is preferable to dimension the energy storage means so that their capacity is sufficient to allow the transponder to function correctly even in "worst case" situations. This achieves the result that, even in the case where the energy storage means are not completely recharged every time, a reliable and reg-

ular series of measured values is nevertheless obtained.

If the transponder is used, for example, for dairy cattle, an interrogation station can be installed, for example, in the vicinity of the milking machine so that the charge in the energy storage means of the transponder is topped up during each milking session, which requires a certain time. An interrogation station can also be installed in the vicinity of the feeding points so that the charge in the energy storage means of the transponder is topped up each time an animal visits the feeding point.

If the transponder is used for pigs, the above-mentioned situations do not occur. On the other hand, the freedom of movement of pigs is often more limited and it is possible, for example, to make use of an interrogation station which is linked to a ring-conductor-type aerial in the pigsty so that the transponder will always be in the interrogation field for a relatively long time and the periods in which the transponder is not in the interrogation field are relatively short. Under those circumstances, the capacity of the storage means in the transponder can be selected as relatively low.

In the above, several embodiments of transponders are described in which the transponder is provided with a single sensor. However, within the scope of the invention, it is also possible to use a plurality of sensors for measuring various parameters, for example a first sensor for measuring temperature and a second sensor for measuring movements. Because not all the sensors need to be active at the same times, it is preferable in that case for the time-determining circuit also to be provided with a selection circuit which indicates at each set or programmed clock time or after each specified period which sensor(s) has(have) to be activated in order to measure the respective current parameter value and store it in the memory.

Claims

1. Transponder provided with:

- a receiving circuit for receiving interrogation signals and electromagnetic field energy,
- energy storage means for storing the received electromagnetic field energy and for delivering power to the transponder,
- interrogation signal processing means for detecting the interrogation signal,
- a measuring circuit coupled to one or more sensors for measuring the value of one or more external ambient parameters,
- and a transmitting circuit which, after reception of an interrogation signal transmits the parameter value(s) measured by the measuring circuit,

characterized

- in that the transponder is furthermore provided with a time-determining circuit which activates the measuring circuit at predetermined times to carry out one or more measurements of the said ambient parameter(s),
- in that the measuring circuit is provided with a memory in which a number of measured parameter values can be stored, and
- in that the energy storage means have sufficient capacity to supply power within a predetermined period to the time-determining circuit in order to keep it in operation during said period and also to supply power to the measuring circuit insofar as it is activated within the said period by the time-determining circuit.

2. Transponder according to Claim 1, characterized in that the energy storage means are provided with a chemically inactive energy storage element such as a capacitor.

3. Transponder according to Claim 1, characterized in that the energy storage means are provided with a chemically active energy storage element such as a battery or storage battery.

4. Transponder according to Claim 1, 2 or 3, characterized in that the time-determining circuit is provided with a clock which can be set or programmed to activate the measuring circuit at the set or programmed clock times.

5. Transponder according to Claim 1, 2 or 3, characterized in that the time-determining circuit is provided with a period measuring circuit which can be set or programmed to activate the measuring circuit always after a certain period.

6. Transponder according to one of Claims 4 or 5, characterized in that

the transponder is provided with two or more sensors and in that the time-determining circuit is also provided with a selection circuit which indicates at each set or programmed clock time or after each specified period which sensor(s) has(have) to be activated in order to measure the respective current parameter value and store it in the memory.

7. Transponder according to one of the preceding claims, characterized in that the sensor or one of the sensors is a temperature sensor.

8. Transponder according to one of the preceding Claims 1-6, characterized in that the sensor or one of the sensors is a pressure sensor.

9. Transponder according to one of the preceding Claims 1-6, characterized in that the sensor or one of the sensors is a humidity sensor.

10. Transponder according to one of the preceding Claims 1-6, characterized in that the sensor or one of the sensors is an electrochemical sensor for measuring, for example, pH, glucose content or the like.

11. Transponder according to one of the preceding Claims 1-6, characterized in that the sensor or one of the sensors is a movement sensor.

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fig-1

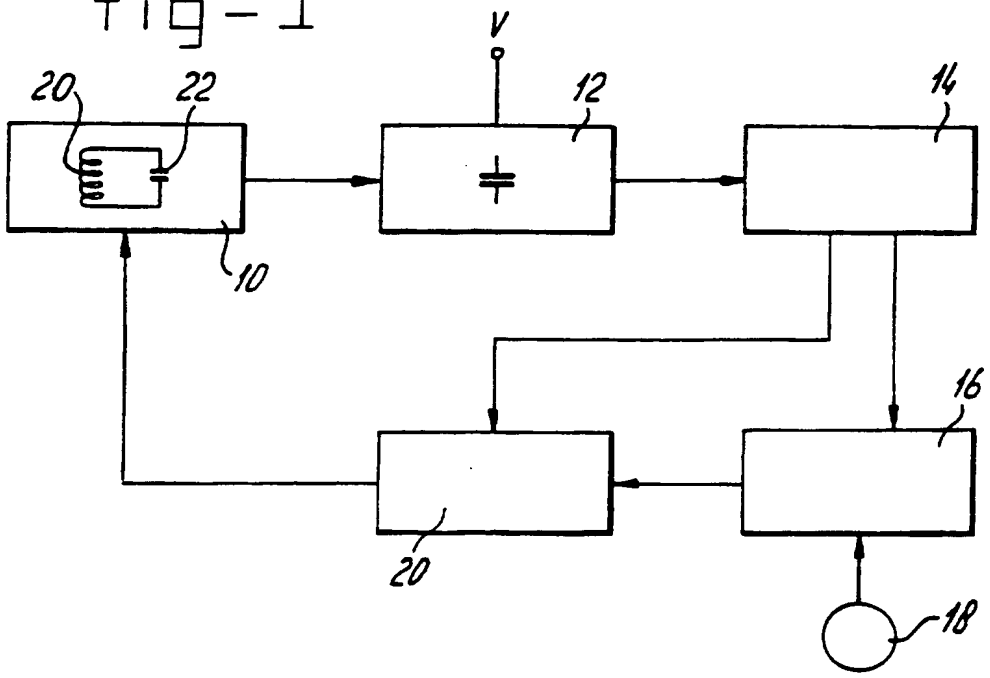
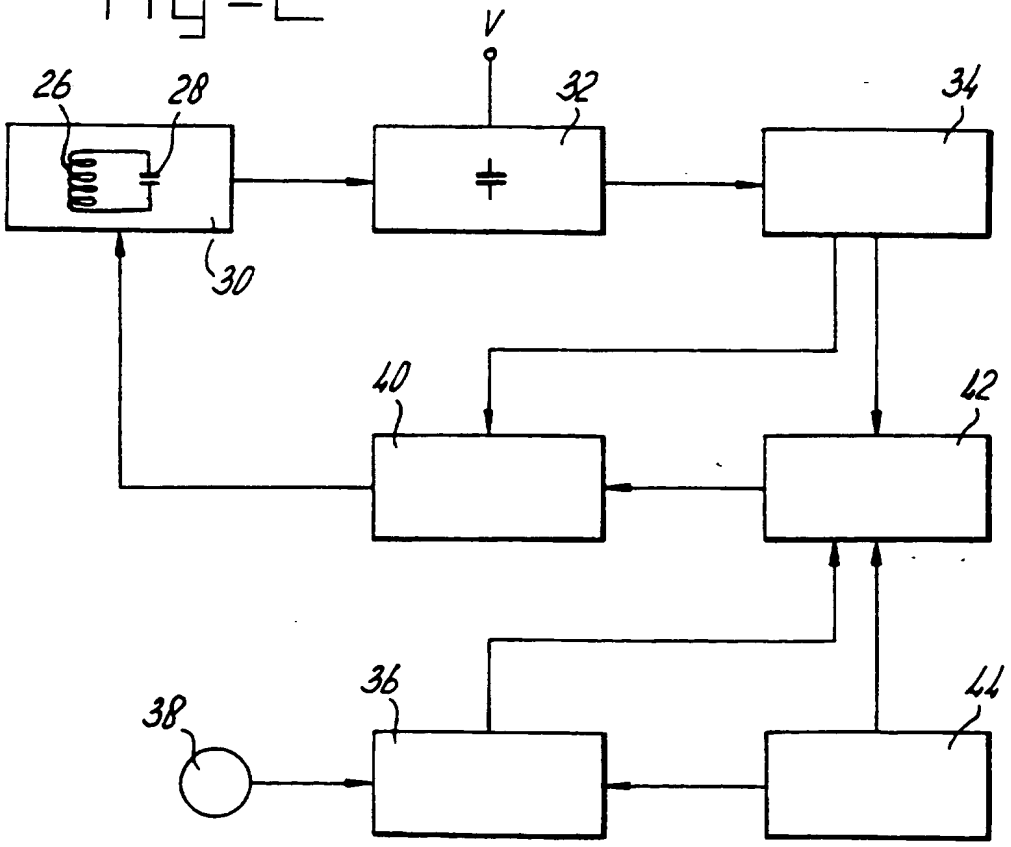


fig-2



INTERNATIONAL SEARCH REPORT

International Application No
PCT/NL 96/00375

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 G01S13/02 G01K1/02

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 G01S G01K

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C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	EP,A,0 301 127 (TEXAS INSTRUMENTS DEUTSCHLAND) 1 February 1989 see the whole document	1-7,10
Y	& US,A,5 053 774 cited in the application	1-7,10
Y	US,A,4 109 527 (GOODE JR JOHN V) 29 August 1978 see the whole document	1-7,10
A	US,A,4 033 186 (BRESIE DON) 5 July 1977 see the whole document	1-8
A	WO,A,93 08451 (SENSITECH INC.) 29 April 1993 see the whole document	1-11

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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO,A,84 00869 (CORNELL RES FOUNDATION INC) 1 March 1984 see the whole document -----	1-11

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Information on patent family members

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PCT/NL 96/00375

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		NO-C-	174123	16-03-94
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APPLICANT: Martin Vossiek et al.

LERNER AND GREENBERG P.A.
P.O. BOX 2480
HOLLYWOOD, FLORIDA 33022
TEL. (954) 925-1100